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FOOD ENGINEERING

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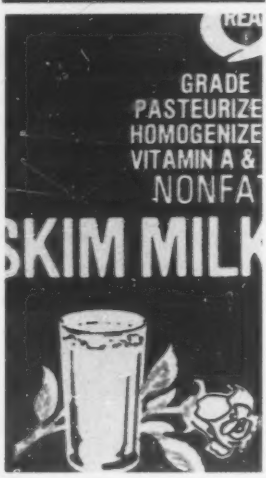
FOOD SAFETY: IS PRODUCTION OUTRUNNING ANALYSIS ?

FOOD ENGINEERING



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FOOD ENGINEERING® (ISSN 0193-323X) August 1987, Vol. 59, No. 8. Published monthly by Chilton Company, Chilton Way, Radnor, Pa. 19089 (Telephone 215/964-4000). Chilton Co. is a division of American Broadcasting Companies, Inc., New York, N.Y. Second Class Postage Paid at Wayne, Pa. 19087 and additional mailing offices. Title registered in U.S. Patent Office. ™Chilton Company, 1987. All rights reserved.

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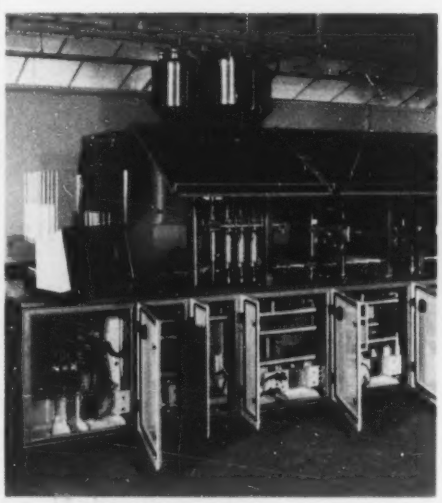

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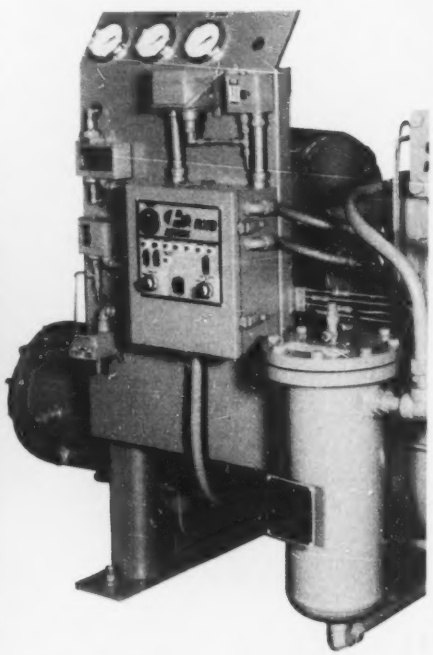

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Special Emphasis

COGENERATION: FUEL PROBLEMS SOLVED BY AN OLD TECHNOLOGY

Food processors are finding that yesterday's technology can offer a solution to one of today's problems: the rising cost of fuel.

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Special Emphasis

COGENERATION

FUEL PROBLEMS SOLVED BY AN OLD TECHNOLOGY

Cogeneration, once a dying industry that seemingly had had its day, has become a solution to the problem of rising energy costs.

Food processors, large and small, are finding that yesterday's technology can offer a solution to one of today's problems: the rising cost of fuel. Fuel prices have increased an estimated sevenfold during the past decade, and further increases have the same inevitability as death and taxes. Cogeneration provides a viable alternative for the food processor, a heavy user of electricity and thermal power, to fill his energy needs in a cost-effective manner, while decreasing his dependence on others for his energy needs.

Cogeneration is the simultaneous production of electrical or mechanical power and thermal energy from a single fuel source. A cogenerator is able to realize enhanced efficiencies because his system uses the same fuel sequentially to do work twice. The first use is in the engine to produce power. The second use is hot water or steam used for heating or cooling purposes. So, for the same amount of fuel, the cogenerator, while he may produce less electricity than a central power plant, will produce more useful energy overall.

"Cogeneration," says Ken Fuginelli of the American Gas Association, "saves energy, cleans up the air, and offers overall thermal efficiency higher than with conventional utilization of energy, thus making better use of natural resources. Cogeneration gives you a lot of flexibility – the flexibility to tailor a system to fit your individual needs."

Typical applications

There are three basic applications of cogeneration technology: industrial, geothermal and waste-to-energy.

Industrial cogeneration usually uses a system where power generation precedes heat generation. Fuel is burned that produces steam, and the steam is expanded through a turbine driving a generator. After passing through the turbine, the reject heat is used to provide process steam.

The Sunkist Growers facility in Ontario, CA is the site of an 11.2 MW cogeneration facility which supplies both steam and electricity to the plant. Excess electricity is sold to the local utility. (Source: International Power Technology).

Food processors are sometimes able to fuel their systems with a wide variety of non-conventional fuels, byproducts of their own operations. (Approximately 44 percent of cogeneration facilities in operation are natural gas-fired, due to much lower installation and operating costs.) However, rice hulls, walnut shells, waste from paper and chemical production, and other processing byproducts are being used around the country to fuel cogeneration systems. Although the economics of a cogeneration project cannot be based on using such unusual fuels, it can add to the feasibility of the project. Just remember: you have a lot of waste to fill significant thermal requirements.

Geothermal applications are used to cost-

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LINDA K. FREEMAN
Contributing Editor

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effectively and efficiently secure the highest rate of return from a production well by making the best use of steam.

Waste-to-energy cogeneration employs mass-burning technology using untreated municipal solid waste (MSW) or refuse-derived fuel (RDF) to produce the steam that powers the steam turbine-generator. Regenerative feedwater heating is often used to improve overall cycle efficiency.

The area of waste-to-energy systems is, according to Tom Eidon of Transamerica Delaval, "a brisk market." Transamerica Delaval supplies turbine generator sets and, says Eidon, "more than half of our activity is now in MSW." Why? Because people never stop generating waste. Using MSW as a fuel source for a cogeneration system is a logical way for local communities to get rid of waste.

Cogeneration's appeal has been wide as users of large quantities of electricity and process steam have seen the economic advantages of cogeneration, causing a "rebirth" of the technology. Food processors have found cogeneration brings a number of advantages, including:

- An increased fuel efficiency of up to 50 percent over the separate production of electricity and steam.
- Containment of future energy costs.
- More effective use of energy resources.
- The ability to reduce pollution, since less fuel is required to produce the same amount of energy.
- A lessening of dependence on the utility for power.

Why is it more economical?

In the U.S., most of the electricity produced by utilities is in steam cycle plants. Fueling these plants is coal or nuclear fuel with varying requirements for other fuels such as oil, natural gas, hydro, etc. Depending on the plant's location, the fuel mix will include varying degrees of oil and natural gas.

In operation, today's basic steam cycle plant has a fuel to power efficiency of about 35 percent. This means that there is a great deal of waste involved. While fuel to power efficiency is improving, current technology in utility-produced electricity still loses three-fifths of the energy of the fuel input. Another ten percent is lost in transportation. This means that overall about one-third of the energy in the fuel delivered to a central power plant ends up being delivered as electricity for use. The rest is lost.

Cogeneration, however, offers a total system efficiency of 80 percent or more. In a typical cogeneration system the engine is usually used to drive an electric generator. An efficiency ranging from 25 to 30 percent is realized when the fuel is converted to electricity. However, where the utility experiences energy waste because a portion of the fuel goes "up the stack," the cogenerator captures that energy and uses it to satisfy thermal requirements. Up to 50 percent or more of the fuel energy goes to this air cogeneration, making the system 80 percent or more efficient.

Determining factors

An efficiency rating of 80 percent sounds awfully good to a food processor, but cogeneration does not *always* produce power and heat at the lowest possible cost. A lot depends on location. In some parts of the U.S. inexpensive power is available and there is sufficient excess generating capacity to indicate that low-cost power will continue to be available. In these areas the life cycle cogeneration costs may be greater than the cost of using conventional utility services. Also, if the cogenerator cannot effectively use both the steam and electricity produced by this system, then cogeneration does not make sense for this operation.

Cogeneration *does* make sense when electricity costs are high, and continue to increase, when low-cost byproduct fuels or renewable resources are available, or when there is a good match between heat and power requirements. In some cases the payback period for a cogeneration system can be two years, for others five to ten.

It also makes sense in areas of the country, such as the Northeast, where utility rates are high and where some nuclear plants have not come on line, or have even gone off line, affecting capacity. In areas such as this where there is no excess capacity, but rather a need for increased capacity to fill industrial and consumer needs for power, cogeneration is viable.

Legislation spurred cogen

One factor that had a major impact on making cogeneration a wise choice for food processors and other quantity energy users was the passage, in 1978, of the National Energy Act, a series of laws enacted by Congress to encourage better management of U.S. energy resources. Part of this legislation was the Public Utilities Regulatory Policy Act, or PURPA.

PURPA contains specific provisions designed to encourage cogeneration. Under

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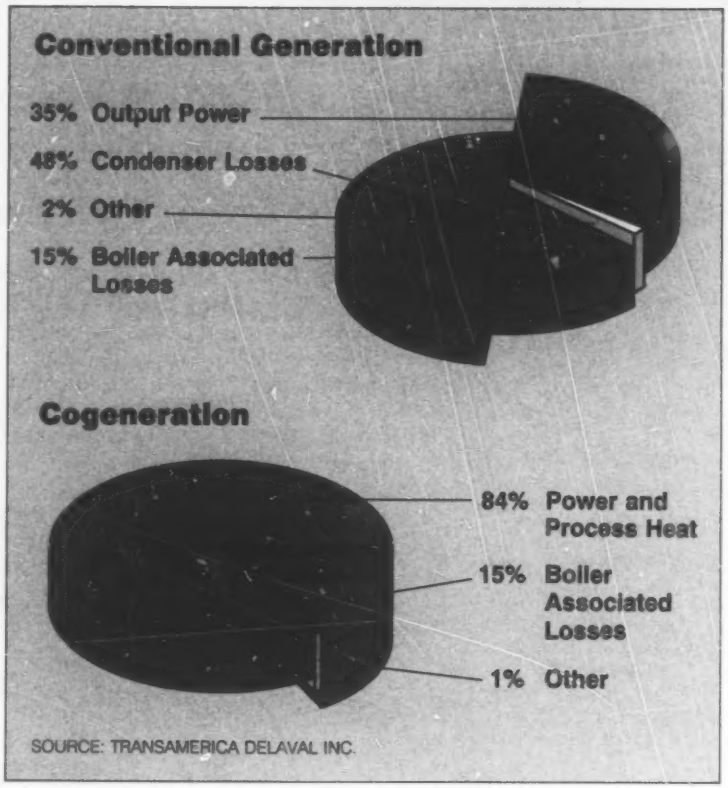
COGENERATION



The efficiency advantages of cogeneration become immediately apparent when compared with conventional power generation.

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PURPA, utilities are required to (1) purchase excess electric power generated by cogenerators at fair prices; (2) provide "standby" or supplemental power to cogenerators; and (3) allow cogenerators to interconnect with the utility grid.

Part of the legislation was that the electric utility would pay the cogenerator all of the cost that the utility would have incurred if it had produced the power itself or purchased it from another utility. This is known as the "avoided cost."

Some utilities are now more cooperative with cogenerators. This varies from region to region, utility to utility, state to state. For example, says Jeff Fisher, of Transamerica Delaval, "In New Jersey, Jersey Central Power and Light needs to purchase excess cogenerated power to supply its customers. In Houston there is enough reserve capacity that they don't need energy produced by cogeneration." The State of New Jersey has formed a separate entity called "Energy Initiatives" to encourage cogeneration and work in concert with companies who are considering the cogeneration technology for their operation.

The ability to negotiate a satisfactory price for excess cogenerated power can make the difference between an installation being economically wise or economically imprudent, but it is something that varies from utility to utility. What is economically viable in one region may not be feasible in another.

The ability to sell power back to the utility can be a determining factor in the economics of the cogeneration system. Where long-term agreements between the cogenerator and the utility can be negotiated, the avoided cost revenues become substantial and can be used as a determining factor in the overall economics of the project and in securing project financing.

The requirement of the utility to supply standby or supplemental power is of equal importance. This means that today's cogenerator does not have to be able to provide *all* of the power required by his operation. Instead the cogenerator can design his on-site system to provide the base amount of power he needs, then use the utility for the rest of his requirements.

Both of these factors, however, vary across the country because each state applies PURPA and the other regulations individually. There is no standard implementation of legislation across the U.S.

"PURPA seems to me to have worked in large measure," says Tom Mason, director of planning and ventures of Energy Factors, a company that develops, finances, engineers, constructs, owns and operates cogeneration facilities.

"Of course," says Mason, "it just provides rules and regulations for the states to implement and it would be desirable if the state implementation of those rules and regulations were consistent – and they are not. It goes according to that state's particular set of problems." Mason feels that one solution to the inequity across the country would be greater involvement by FERC, but that would also infringe upon the state's individual rights.

To reap the rewards of the legislation contained in the National Energy Act, a cogenerator must fulfill certain requirements and become a Qualifying Facility (QF). In order to become a QF with Qualifying Status (QS), a cogenerator must provide two useful forms of energy, thermal and power. FERC has established guidelines for the cogenerator detailing the requirements for certification.

Is it viable?

Determining whether cogeneration is a logical pathway for a food processor is not a simple task. An in-depth engineering sur-

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Filling the processor's fluctuating steam needs

An 11.2 MW cogeneration facility supplies energy to the Sunkist Growers, Inc., Ontario, CA facility, powered by two Cheng Cycle Series 7-Cogen systems. Each Series 7-Cogen system produces up to 5.6 MW of electricity or 45,000 lbs/hr of steam.

The Cheng Cycle, is designed specifically for users whose steam requirements show peaks and valleys in demand. The system employs precisely controlled steam injection to boost cogeneration output and fuel efficiency. In operation, superheated steam is injected into a turbine combustion system to increase overall turbine mass loadings without raising inlet temperatures.

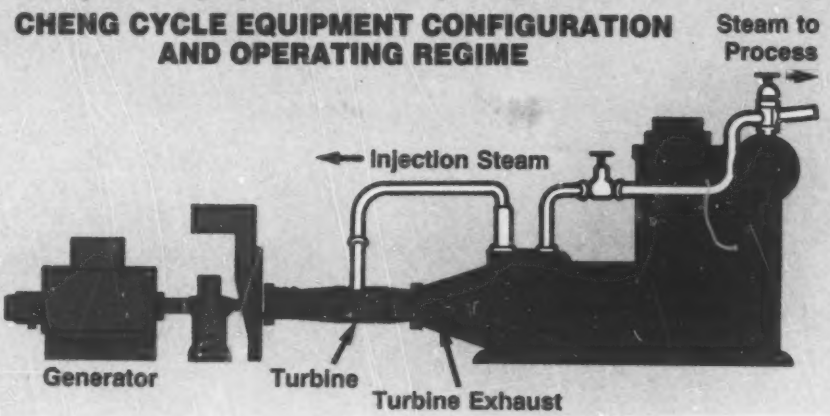
What made the use of the Cheng Cycle systems the logical choice was the plant's fluctuating need for steam. The plant processes fruit year-round, but season-to-season steam loads vary significantly, ranging from nearly zero to a maximum of 80,000 lbs/hr during peak demand periods.

Sunkist uses the steam from the plant to produce citrus concentrate and to fill space heating requirements in the processing plant. The system also supplies Sunkist's electrical needs, which range from 3.5 to 6.8 MW. Excess electricity is sold to the local utility. It is expected that with the installation of the facility Sunkist will see about a 10 percent savings in energy costs—not a tremendous amount, but sufficient enough to make the project a viable one.

The system was installed by International Power Technology who entered into a sale/leaseback leveraged lease transaction with Citicorp Industrial Credit (CIC). Union Bank provided construction financing and long term credit support. A wholly owned subsidiary of IPT is now leasing the facility from CIC through 1999. Sunkist reaps the economic benefits of lower steam plant operating costs and a portion of the cogeneration profits.

In the Cheng Cycle (shown below), steam is injected into the turbine to increase efficiency by as much as 40 percent and power by as much as 60 percent. The amount of steam injected can vary from minute to minute, depending on steam loads and electricity buy-back rates.

CHENG CYCLE EQUIPMENT CONFIGURATION AND OPERATING REGIME



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vey is necessary to look at present needs and the potential for the future. The engineering study would include four basic parts: site conditions, utility information, economic assumptions and engine specifics.

In addition, says Mason of San Diego-based Energy Factors, there are three analyses that must be performed: An economic analysis, a sensitivity analysis and a risk analysis.

To conduct an Economic Analysis, says Mason, look at the revenues produced by the facility from electrical and thermal sales, and subtract from them the costs for fuel, operation, maintenance, insurance, property taxes, and other costs of with the project, such as financing costs and tax considerations.

To accomplish the Sensitivity Analysis you need to vary the key components involved, such as fuel costs, interest rates, electric power rates, steam share rates, inflation rate, etc. to see how the economics react to those changes. "This," says Mason, "gives you some assurances that, given the uncertainty that lies ahead in the components, within ranges, that your project doesn't become unprofitable."

The Risk Analysis looks at those risks in the project that might stand in the way of the ultimate completion of the project—factors such as environmental permitting, financial permanency, tax considerations. "This gets very site specific," says Mason.

As mentioned before, each project has its own special needs and requirements that vary with states, sites and utilities. There are, however, three forms of ownership of a cogeneration project: industrial, third-party or utility.

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Knowing the obstacles (permitting, taxes, financing) and having the experience to overcome them is why a lot of cogenerators turn to a third party for help. "We have been through these things so many times so we know what risks we are looking for and how to evaluate them," says Tom Mason.

Third party companies, such as Energy Factors, and Solar Turbines of San Diego, offer the advantage of years of cogeneration experience. Solar Turbines, a subsidiary of Caterpillar, Inc. designs and produces completely integrated turbomachinery packages and systems. Through its sister subsidiary, Caterpillar Capital, the company offers third party services, such as ownership of the cogeneration facility, management services, engineering, purchasing and maintenance.

There are as many ways to structure a cogeneration facility agreement as there are kilowatts. Susan Brauer of Solar Turbines puts it this way: "We can take responsibility for the entire project. Some companies want to use their own people, others want to use an outside company to maintain and operate. Our prime concern is that the project work and the customer is getting what they want."

Third party development presents a good option according to Walter Thurston, marketing communications manager at International Power Technology (IPT). "It takes away the risk for the food company." Thurston says. "The food processing industry has not been in the business of selling power, so many managers realize it makes sense to have someone else take care of that." He estimates that half of cogeneration projects are third-party projects.

Selling back the power to the local utility, or negotiating the "buyback" agreement can be crucial to the success of a cogeneration project. Often the experience and knowledge of having dealt with the utilities and knowing how best to negotiate with them is another factor that makes the use of a third party an important consideration.

Some food processors, however, want to do it themselves, particularly those with large operations who can afford to handle the financing, maintenance and operational expenses themselves. Often these companies have the strength to effectively negotiate an agreement with the local utility.

Ken Fuginelli, vice president of marketing services for the American Gas Association, cites Campbell Soup as an example. "If you are a large cogenerator such as Campbell Soup, you will be able to generate a sizable capacity yourself and then buy the rest (from the local utility). You can cogenerate your base load and buy your peak load."

You don't have to be the size of a Campbell Soup, however, to make cogeneration pay off. Although smaller cogenerators might have a longer payback period or might not realize quite the same return on investment as a larger cogenerator, that is not to say that the economies are not there.

However, with the availability of smaller scale cogeneration units, more and more smaller processors are finding this century-old technology can work for them. By installing a system that can provide their base load electrical needs (purchasing power from the utility only at peak times), a processor can also fill his processing steam needs or fuel his refrigeration facilities independent of anyone else.

There are a number of package cogeneration systems available that will supply heating, air-conditioning and hot water all coming out of one unit. A pad is laid next to the building or on the roof, then the system is placed upon it. It's simple, and efficient. McDonald's restaurants have made use of such systems not only to fill their electrical demands, but using the hot water supplied to satisfy the restaurant's needs, and using the heat generated to keep the restaurant warm in winter.

Prepackaged systems "are coming more and more into vogue," says Fred Rambert, production manager at Waukesha Power Systems. "The problem is that it usually costs more dollars per kilowatt than with the large package. It usually takes almost as much engineering and design work for a small unit as it does for the big ones."

The future

The future looks optimistic for cogeneration. Although the Tax Reform of 1986 took away some of the tax advantages for cogenerators (including loss of the Investment Tax Credit), this should not significantly affect the viability of a project. "If you were in it for the tax advantages, you weren't very smart," says Waukesha's Rambert.

The number of requests for certification submitted to the FERC points to the "brisk market" mentioned by Tom Eidon of Transamerica Delaval. It is a market that should continue to grow. The legislation is there to encourage it, utilities are becoming slowly more receptive to it, and more and more industrial operations are realizing the economic value of generating their own electricity and thermal power.